

Lyophilization Cycle Development & Optimization: A Laboratory Based Approach

DAY 1. We will begin promptly at 8:00. The facility will be open at 7:30 for your arrival

8:00 – 8:30	Instructor’s Opening Address Course introduction and format * Instructor & participant introductions * Course goals	Jeff Schwegman, Ph.D.
8:30 – 9:00	Physical Properties of Materials Crystalline vs. amorphous vs. mixed systems * Eutectic melting, glass transition & collapse temperatures * Partial collapse vs. melt-back * Examples of failed products	Jeff Schwegman, Ph.D.
9:00 – 9:30	Materials Characterization Techniques Principals of thermal analysis * Thermal analysis techniques (DSC, DTA, TEA) * Freeze dry microscopy equipment & techniques * Applications of thermal analysis and freeze-dry microscopy techniques for solutions and solids	Jeff Schwegman, Ph.D.
9:30 – 9:45	Break	
9:45 – 10:30	Freeze Dry Microscopy	Biopharma Technology <i>(Thomas Codd)</i>
10:30 – 12:00	Freezing, Annealing, Primary, and Secondary Drying Ice nucleation * Ice crystal growth * Effects of ice crystal particle size * Eutectic and/or glass formation * Annealing theory and techniques * Primary and secondary drying and protocols	Jeff Schwegman, Ph.D.
12:00 – 1:00	Lunch	
1:00 – 2:00	DSC for Thermal Analysis	TA Instruments <i>(Kadine Mohomed, Ph.D.)</i>
2:00 – 5:00	Laboratory Sessions – Group Rotations (1.5 hour each, take breaks as needed) Station 1: Differential Scanning Calorimetry Station 2: Freeze Dry Microscopy Station 3: Introduction to LyoStar, MTM/SMART Station 4: Introduction to Shelf Freeze Dryers	Laboratory Station 1: TA Instruments Station 2: Biopharma Station 3: Don Pawelko Station 4: Damon Pizzurro

Please note that breaks will be taken during the lab session as needed

Meet for Dinner at 6:15 PM

Lyophilization Cycle Development & Optimization: A Laboratory Based Approach

DAY 2. We will begin promptly at 8:00. The facility will be open at 7:30 for your arrival

8:00 – 11:00	<p>Laboratory Sessions – Group Rotations (1.5 hour each, take breaks as needed)</p> <p>Station 1: Differential Scanning Calorimetry</p> <p>Station 2: Freeze Dry Microscopy</p> <p>Station 3: Introduction to LyoStar, MTM/SMART</p> <p>Station 4: Introduction to Shelf Freeze Dryers</p>	<p>Laboratory</p> <p>Station 1: TA Instruments</p> <p>Station 2: Biopharma</p> <p>Station 3: Don Pawelko</p> <p>Station 4: Damon Pizzurro</p>
11:00 – 12:00	<p>Laboratory Sessions (Break as needed)</p> <p>Each group will be assigned a freeze dryer. Utilizing the thermal analysis and lecture information presented so far students will develop a thermal treatment protocol, program the freeze dryer and then load product and start the freezing portion of the cycle. Groups will spend time explaining their choice of protocol later in the course.</p>	<p>Laboratory Thermal Treatment</p> <p>Don Pawelko Damon Pizzurro</p>
12:00 – 1:00	Lunch	
1:00 – 2:00	<p>Lyophilization Process Development & Cycle Design</p> <p>Reviewing & utilizing the pre-formulation/formulation data *</p> <p>Reviewing & utilizing thermal analysis * Designing an optimized freezing protocol * Designing and optimized primary drying protocol</p> <p>* Designing an optimized secondary drying protocol</p> <p>* Characterizing the final dried formulation</p>	Jeff Schwegman, Ph.D.
2:00 – 3:00	<p>Formulation of a Lyophilized Product</p> <p>Formulation considerations * Buffers * Bulking Agents *</p> <p>Lyoprotectants/Cryoprotectants</p>	Jeff Schwegman, Ph.D.
3:00 – 5:00	<p>Laboratory (Break as needed)</p> <p>Students will develop a drying protocol for their product and program the drying steps into the freeze dryer. Real-time adjustments will then be made to the protocol based on process data. Each group should note the status of their cycle and make observations of the status of the freeze drying cycle.</p>	<p>Laboratory Primary Drying</p> <p>Don Pawelko Damon Pizzurro</p>

Please note that breaks will be taken during the lab session as needed

Meet for Dinner at 6:15 PM

Lyophilization Cycle Development & Optimization: A Laboratory Based Approach

DAY 3. We will begin promptly at 8:00. The facility will be open at 7:30 for your arrival

8:00 – 8:30	<p align="center">Laboratory</p> <p>Each group should note the status of their cycle and make observations of the status of the freeze drying cycle. Adjustments should be made if necessary</p>	Jeff Schwegman, Ph.D.
8:30 – 9:15	<p>Scale-Up, Cycle Transfer & Maximum Throughput Capability</p> <p>Critical parameters in scale-up and cycle transfer * Scale-up strategy * Mapping studies * Dryer configuration * Determining and preventing choked flow conditions</p>	Jeff Schwegman, Ph.D.
9:15 – 9:30	Break	
9:30 – 10:30	Critical Quality Attributes of Lyophilized Products	Lyophilization Technology <i>(Andrew Smith)</i>
10:30 – 11:15	NIR for Lyophilized Sample Analysis	Thermo Scientific <i>(Herman He, Ph.D.)</i>
11:15 – 12:00	Tunable Diode Laser Absorption Spectroscopy (TDLAS)	Physical Sciences Inc. <i>(Bill Kessler)</i>
12:00 – 1:00	Lunch	
1:00 – 5:00	<p align="center">Laboratory Sessions (45 min sessions, take breaks as needed)</p> <p>Students to remove samples from the dryer prior to going to stations.</p> <p>Station 1: Karl Fischer Residual Moisture Analysis</p> <p>Station 2: Physical Appearance & Reconstitution</p> <p>Station 3: The Use of TDLAS to Measure Mass Flow</p> <p>Station 4: NIR Residual Moisture Analysis</p>	<p align="center">Laboratory</p> <p>Station 1: Lyophilization Technology</p> <p>Station 2: Lyophilization Technology</p> <p>Station 3: Physical Sciences Inc.</p> <p>Station 4: Thermo Scientific</p>

Please note that breaks will be taken during the lab session as needed

Meet for Dinner at 6:15 PM

Lyophilization Cycle Development & Optimization: A Laboratory Based Approach

DAY 4. We will begin promptly at 8:00. The facility will be open at 7:30 for your arrival

8:00 – 8:30	Container Closure Systems Selection of containers and closures * Proper Preparation of Container Closure Systems (Lab vs. Production) * Specialized Coatings and Formulations	Jeff Schwegman, Ph.D.
8:30 – 9:30	Production Dryers, Auto-loading, and Scale-Up	Paul Coiteux
9:30 – 10:15	Facility Tour	Paul Coiteux
10:15 – 10:30	Break	
10:30 – 11:00	Student Report Preparation	
11:00 – 11:30	Students Present Reports & Discuss	
11:30 – 11:45	Case Studies	Jeff Schwegman, Ph.D.
11:45 – 12:15	Final Discussion & Remarks	Jeff Schwegman, Ph.D.
12:15 – 1:15	Lunch	
	End of Course – Thank You for Attending!	